Operating Experience Weekly Summary 97-40

September 26 through October 2, 1997

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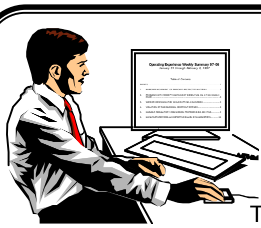

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EVENTS

1. DROPPED FUEL CANISTER AT HANFORD

On September 29, 1997, at the Hanford Site K-Basins, operators dropped a fuel canister containing 14 pieces of zircoloy-clad fuel during a transfer operation. The canister fell approximately 1 foot from a straight-hook on a chain-fall and came to rest at approximately a 60 degree angle, partially inside a fuel rack. The facility manager directed operators to stop all other fuel movements. Operations personnel performed an inspection of the canister and fuel and determined that there was some fuel damage. Investigators believe the fuel assemblies inside the canister were damaged previously, possibly when they were discharged from the reactor. They have not determined what caused the canister to fall. Dropped fuel assemblies can result in fuel assembly damage, release of fission products, or accidental criticality. (ORPS Report RL--PHMC-KBASINS-1997-0021)

The facility manager held a critique of the event. Critique members determined that an operator was moving the canister from a fuel storage rack so an adjacent, out-of-position, rack could be repositioned. He engaged the fuel canister with the straight-hook on an electric chain-fall that is routinely used to move canisters. Lifting and rigging personnel are making slings to be used to recover the canister. Facility personnel continue to review this event to determine the cause. Further investigation and recovery of the dropped canister are required before fuel movement activities can resume. Figure 1-1 shows a typical canister-handling layout.

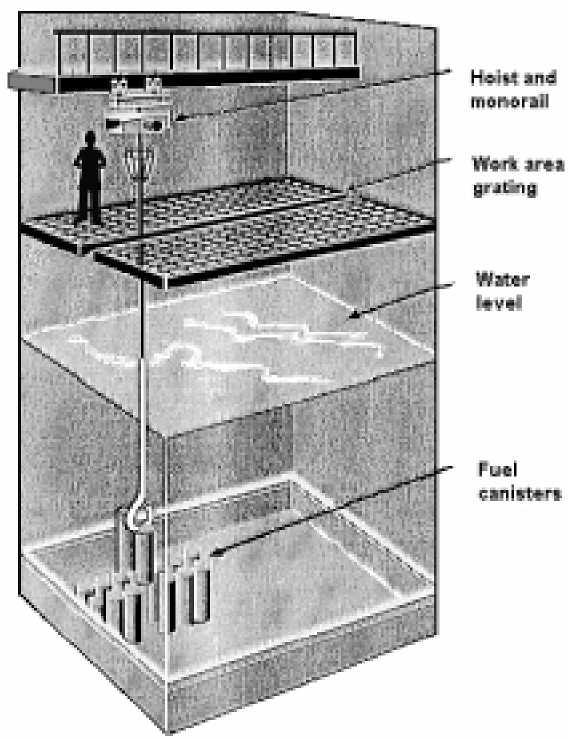


Figure 1-1. Canister-Handling Layout

NFS has reported on fuel-handling events in several Weekly Summaries. Following are some examples.

- Weekly Summary 97-29 reported that fuel-handling personnel at Idaho National Engineering Laboratory, dropped an empty fuel canister approximately 12 feet while moving it into a fuel storage area. During canister movement, the operators noticed that the lifting bail of the canister was not properly engaged with the crane hook. They were trying to place the canister into a shuttle bin when the canister fell. The canister landed vertically and fell to a horizontal position on the floor within a few feet of the fuel storage racks. (ORPS Report ID--LITC-FUELRCSTR-1997-0009)

- Weekly Summary 97-23 reported that operators at the Savannah River Site dropped an aluminum-clad fuel assembly when transferring it from a storage hanger to a vertical disassembly machine. The top of the assembly came to rest on an underwater column, tilted at 60 degrees. Operators recovered and inspected the fuel assembly and discovered corrosion around the lip engaged by the fuel gripper tool. (ORPS Report SR--WSRC-REACK-1997-0006)

- Weekly Summary 94-49 reported that operators at the Receiving Basin for Offsite Fuels Facility at the Savannah River Site dropped a fuel assembly when it came loose from a gripping tool. Fuel-handling personnel were removing fuel assemblies from a shipping cask sent to the United States from Europe. When the assembly was moved, it dropped out of the tool, and landed horizontally across the fuel storage basket in the cask. Operators retrieved the assembly, inspected it, and found no damage. Facility personnel determined that the tool had only gripped the top one-half inch of the assembly and this was insufficient to handle the weight of the assembly. (ORPS Report SR--WSRC-RBOF-1994-0021)

OEAF engineers also reviewed a recent occurrence report about an out-of-position spent fuel rack at Hanford K-Basins. On June 16, 1997, an operator identified a mis-positioned spent fuel storage rack. Investigators determined that the rack contained 13 canisters of irradiated reactor fuel. They also determined that the root cause of the event was personnel error (inattention to detail) because the operators had mis-positioned the rack during fuel- movement activities. A criticality safety recovery team developed corrective actions to re-position the rack, including (1) removing all fuel canisters from the affected area, (2) repositioning the rack to the proper orientation, and (3) revising operations procedures to require an operator to observe loads during any movements in the basin to ensure the racks are not affected. (ORPS Report No. RL--PHMC-KBASINS-1997-0011)

OEAF engineers have reported fuel-handling events at DOE facilities that involved dropped fuel, fallen fuel, dropped canisters, and incorrectly positioned fuel assemblies. These events underscore the need to ensure complete, positive control during fuel handling. Procedures should be used for these operations because fuel-handling is often an infrequent task that is usually performed remotely. In addition, facility managers should consider (1) the affects of corrosion on stored spent fuel, (2) the design of fuel storage facilities, and (3) the need for a DOE-wide fuel policy to deal with the range of spent fuel problems across the complex. The effects of corrosion need to be an important consideration in all fuel-handling operations. Corrosion of spent fuel not only affects the integrity of the fuel-cladding, leading to possible fission product release, but increases the risk of a fuel-handling accident because of degraded lifting points or deterioration of the storage canisters.

In 1993, the DOE Spent Fuel Working Group issued a three-volume report on the inventory and storage of spent nuclear fuel. The report contains additional information on corrosion problems at DOE spent fuel storage facilities. An attachment discusses corrosion and chemistry considerations for aluminum-clad fuel and target slugs. The report can be accessed through the ES&H Technical Information Services Home Page at http://tis.eh.doe.gov/docs/spent_fuel.html.

KEYWORDS: fuel handling, corrosion, canister

FUNCTIONAL AREAS: Operations, Nuclear/Criticality Safety

2. INADEQUATE LOCKOUT OF SWITCHGEAR RESULTS IN ELECTRICAL SHOCK

OEAF engineers reviewed two occurrence reports this week involving inadequate lockout and tagout of electrical switchgear for preventive maintenance. On September 27, 1997, at the Oak Ridge National Laboratory, an electrician received an electrical shock and minor burn when he placed his hand on an energized 480-volt incoming feed. On September 27, 1997, at the Savannah River Site, mechanics discovered an energized 120-volt circuit in a motor control center during a zero-energy check. These events are significant because inadequate lockouts of electrical equipment can result in personnel injuries or fatalities. To ensure positive isolation of energized circuits and minimize electrical shock hazards to personnel, lockout and tagout preparers must identify all isolation boundaries. OSHA estimates that 120 fatalities, 28,000 serious injuries, and 32,000 minor injuries would be prevented each year if lockouts and tagouts were performed in accordance with the standards in 29 CFR 1910.147. (ORPS Reports ORO--ORNL-X10HFIR-1997-0016 and SR--WSRC-WVIT-1997-0028)

Investigators at Oak Ridge determined that two electricians were performing 3-year preventive maintenance on a 480-volt switchgear motor control center at the High Flux Isotope Reactor. The maintenance work package instructed them to clean, inspect, and test the motor control center panels. They commenced the work on Tuesday, September 23. At that time, a lockout/tagout was in place, and the electricians performed a zero-energy check and verified that the switchgear was de-energized. Operators cleared the lockout on Friday after the electricians completed maintenance on one of two panels. On Saturday, September 27, the two electricians continued the preventive maintenance under a new lockout/tagout. They assumed, because the equipment was de-energized the previous week with a similar lockout, that they did not have to perform another zero energy check. One of the electricians placed his hand on an energized incoming feed and received an electrical shock. Medical personnel at the Oak Ridge Medical Center treated him for a minor burn on the hand and released him to return to work.

The facility manager stopped all electrical work at the High Flux Isotope Reactor site and conducted a critique of the event. Critique members determined that operators installed an inadequate lockout/tagout of the motor control center on Saturday because the second panel had two electrical feeds and the lockout preparer failed to identify the second source of power.

Investigators at Savannah River determined that mechanics were preparing to perform preventive maintenance (inspection and cleaning) on a motor control center when they discovered voltage in the work area during a zero-energy check. The mechanics stopped all work and notified their supervisor. Investigators determined that the lockout/tagout preparer failed to include isolation of a 120-volt control power circuit, even though this information was available on drawings.

NFS has reported numerous inadequate electrical lockout events in the Weekly Summary. The following two examples have occurred this year.

- Weekly Summary 97-31 reported that a subcontractor mechanic at the Savannah River Site installed a lockout to de-energize a 480-volt electrical source to troubleshoot and repair a laboratory heating, ventilation, and air conditioning system. While the mechanic was working on the system, an auditor discovered that the cabinet contained an energized 120-volt electrical feed in addition to the 480-volt source. Investigators determined that the inadequate lockout/tagout was the result of a failure to thoroughly research the isolation boundaries. (ORPS Report SR--WSRC-TNX-1997-0005)

- Weekly Summary 97-03 reported that a lockout coordinator at the Savannah River Tritium Facility mistakenly used a pre-existing lockout to provide protection for work on a power distribution panel. However, the pre-existing lockout did not provide complete electrical isolation to the panel. Construction electricians cut a hole in the panel and installed a 2-inch conduit in an area where exposed, energized, 208-volt wiring existed. (ORPS Report SR--WSRC-TRIT-1997-0001)

OEAF engineers reviewed the ORPS database for inadequate lockouts across the DOE complex and found 49 occurrences. Figure 2-1 shows that facility managers reported personnel error as the root cause for 39 percent of the occurrences. They also reported that management problems accounted for 27 percent of the violations. Further review shows that 47 percent of the personnel errors were reported as inattention to detail, and 46 percent of the management problems were reported as work organization/planning deficiency.

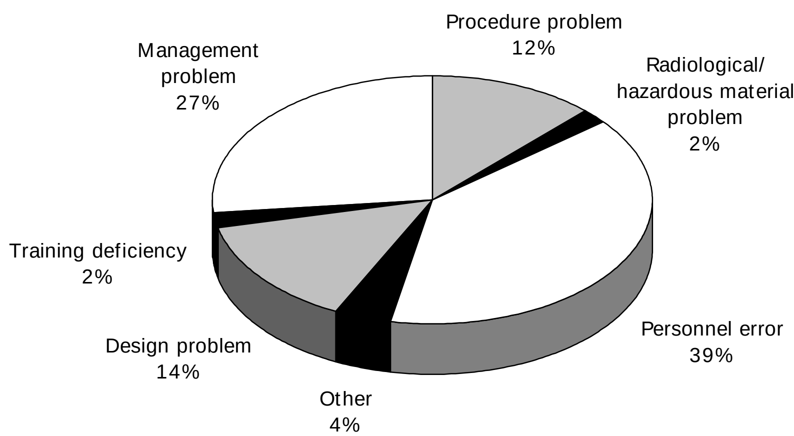


Figure 2-1. Distribution of Root Causes for Inadequate Lockouts[1]

These events underscore the need for lockout preparers to ensure that the lockout/tagout addresses all isolation boundaries. It is also important for the worker to verify these boundaries and to perform a zero energy check. Personnel performing zero energy checks on electrical equipment should use only approved test equipment that has been verified operable and should know where in the system to perform these checks. DOE-STD-1030-96, *Guide to Good Practices for Lockouts and Tagouts*, states that every isolation from an energy source must be verified. The initial verification should include a review of pertinent controlled drawings or manuals and a hands-on check of the equipment to help identify obscure sources of power. Although both the Oak Ridge and Savannah River events involved inadequate lockouts, injury was avoided at Savannah River because a zero-energy check identified the shock hazard. Facility managers should review DOE/EH-0540, Safety Notice No. 96-05, "Lockout/Tagout Programs." The notice summarizes lockout/tagout events at DOE facilities, provides lessons learned and recommended practices, and identifies lockout/tagout program requirements. Safety Notice 96-05 can be obtained by contacting the ES&H Information Center, (301) 903-0449, or by writing to ES&H Information Center, U.S. Department of Energy, EH-72/Suite 100, CXXI/3, Germantown, MD 20874.

KEYWORDS: lockout and tagout, energized equipment, shock

[1] OEAF engineers searched the ORPS database using the graphical user interface for “inadequate lockout” with the all narrative search and found 48 reports with 49 occurrences.

FUNCTIONAL AREAS: Operations, Electrical Maintenance

3. CONFINED SPACE VIOLATIONS

This week OEAF engineers reviewed two events about confined space entry violations. On September 18, 1997, at Brookhaven National Laboratory, two technicians worked in a cryogenic valve box without satisfying all of the requirements for confined space entry. On September 29, 1997, an inspector at Oak Ridge National Laboratory entered a confined space without an approved confined space entry permit. No safety or health consequences resulted from these two events. According to OSHA, failure to follow confined space requirements results in approximately 63 occupational fatalities per year in the United States. (ORPS Reports CH-BH-BNL-BNL-1997-0030 and ORO--ORNL-X10PLEQUIP-1997-0010)

Brookhaven investigators determined that a facility safety representative had gone to the valve box to observe the work the technicians were performing. He observed the following violations. He knew that one of the technicians had failed an exam for confined space training and should not have been working in the valve box. He also knew that the other technician had not received respirator training, although he wore a supplied air respirator. The safety representative also observed that a safety watch was not present for the job. He issued a stop work order and notified the project head's assistant. Investigators determined that one of the technicians was the designated safety watch. However, he decided to help the other technician, leaving no one to perform the safety watch. After the event, one technician completed re-training in confined spaces, and the other one completed respirator training. Investigators also determined that safety and environmental protection personnel violated procedural requirements by issuing a respirator to an unqualified individual. The project head's assistant directed safety and environmental protection personnel to implement changes to ensure that the laboratory procedures for respirator issuance are fully implemented.

For the Oak Ridge event, the inspector was performing an annual inspection of a de-aerator heater storage unit. Investigators determined that he arrived at the job site believing industrial hygienists had reviewed and approved the confined space permit. They also determined that an industrial hygienist had written, reviewed, and approved a safety work permit for the job. However, industrial hygiene personnel had not completed their review or approved the confined space permit.

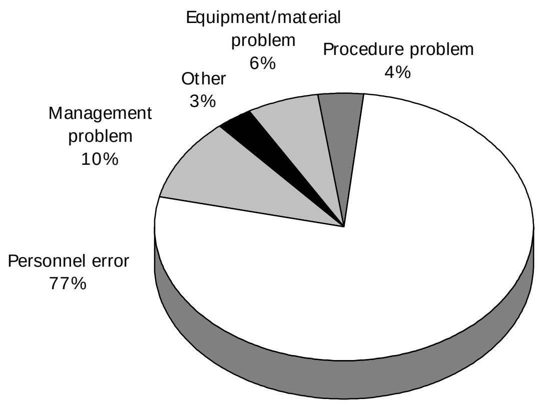
NFS has reported violations of confined space entry requirements in Weekly Summaries 97-11, 96-38, and 96-35. In addition, the Associated Press published an article about three fatalities that occurred in a confined space at Newport News Shipyard. Following are details of the fatalities at the shipyard and the Weekly Summary articles.

- Weekly Summary 97-11 reported that a subcontract worker at the Savannah River Site violated a confined space work permit (procedure) by working in a confined space without continuous air monitoring or signing the permit. The worker was removing contaminated sludge from a tank using a vacuum pump. (ORPS Report SR--WSRC-RMAT-1997-0003)

- Weekly Summary 96-38 reported that a Sandia National Laboratory subcontractor entered a confined space without calibrated, inspected monitoring equipment; without an attendant; and without a posted confined space permit. (ORPS Report ALO-KO-SNL-CASITE-1996-0009)

- In July 1997, the Associated Press reported that three pipefitters at Newport News Shipyard were overcome by methane gas when working in a pump room aboard the USS Harry S. Truman (CVN-75). The pump room had flooded with liquid sewage to a level approximately 2 feet from an overhead hatch and was approximately 30 feet below the ship's water line. The ship was evacuated, and re-entry teams determined that the ship's atmosphere reached toxic levels in an area approximately half-way between the main deck and the pump room. Rescue teams found all three workers dead 12 hours after the accident. OSHA is investigating the accident.

OEAF engineers reviewed the ORPS database and found 71 reports associated with confined space violations. Figure 3-1 shows that facility managers reported personnel error as the direct cause for 77 percent of these events. Further review determined that procedure not used or used incorrectly accounted for 85 percent of the personnel errors.



Personnel Error	**Percent**
Procedure not used or used incorrectly	85
Inattention to detail	13
Communication problem	2

Figure 3-1. Direct Causes for Confined Space Violations[1]

OSHA reports that approximately 60 percent of confined space fatalities are would-be rescuers and estimates that 85 percent of deaths and injuries in confined spaces could be prevented if sound confined space entry permit programs were implemented. Following are examples of OSHA case reports for rescuer fatalities.

- A construction worker died while attempting to refuel a gasoline-engine powered pump used to remove water from a 66-inch-diameter line that was under construction. The pump was approximately 3,000 feet from where the worker had entered the line. The worker was overcome by carbon monoxide. A co-worker, who had also entered the line, escaped. A state inspector entered from another point along the line and died in a rescue attempt. Both deaths were due to carbon monoxide intoxication. In addition to the fatalities, 30 firefighters and 8 construction workers were treated for carbon monoxide exposure.

- Two workers were overcome by gas vapors and drowned after rescuing a third worker from a fracturing tank at a natural gas well. The tank contained a mixture of mud, water, and natural gas. The first worker had been attempting to move a hose from the tank to another tank. The hose was secured by a chain and when the worker moved the hose, the chain fell into the tank. The worker entered the tank to retrieve the chain and was overcome.

- A worker died inside a toluene storage tank that was 10 feet in diameter and 20 feet high while attempting to clean the tank. The worker entered the tank through the 16-inch-diameter top opening using a one-half inch rope for descent. Although a

[1] OEAF searched the ORPS database using the graphical users interface for reports with all narrative containing "confined space" AND violation@ and found 71 reports. Based on a random sampling of 25 events, OEAF engineers determined that each slice is accurate within ± 1 percent.

self-contained breathing apparatus was present, the worker was not wearing it when he entered the tank. The worker was overcome and collapsed onto the tank floor. In an attempt to rescue the worker, fire department personnel began cutting an opening into the side of the tank. The tank exploded, killing one firefighter and injuring 15 others.

Facility managers and personnel responsible for implementing confined space entry programs should ensure that all aspects of OSHA standards are incorporated into procedures and effectively implemented by workers who enter confined spaces. OSHA also requires training to ensure that employees involved in confined space work can perform their job functions safely. This training covers specific items for the authorized entrant, the attendant, and the entry supervisor. Training for confined spaces should be rigorous and should ensure that workers understand the requirements as well as the potential consequences of their actions.

OSHA Standard 29 CFR 1910.146, *Permit-Required Confined Spaces*, contains requirements for practices and procedures to protect employees from hazards of entry into permit-required confined spaces. The standard requires employers to develop and implement the means, procedures, and practices necessary for safe permit space entry operations; including, but not limited to, the following.

- identifying and evaluating permit space hazards before entry
- establishing and implementing means to prevent unauthorized entry
- establishing and implementing means to eliminate or control hazards necessary for safe entry
- providing, maintaining, and requiring the use of personal protective equipment necessary for safe entry
- requiring testing of atmospheric conditions inside the space before entry
- ensuring that at least one attendant is stationed outside during entry
- coordinating with any contractors used
- implementing rescue procedures
- establishing a written permit system
- reviewing the permit system annually

Appendix A of OSHA 1910.146 provides a decision flow chart to assist personnel in implementing an effective confined space program. Appendix C of this standard provides examples of permit-required confined space programs. OSHA 1910.146 is located at URL http://www.osha-slc.gov/.

DOE/EH-0353P, *OSH Technical Reference Manual*, chapter 4, “Confined Space Entry,” provides a checklist for employees and supervisors to follow. This checklist is available on the internet through the DOE Environment, Safety and Health Technical Information Services. It is located at URL http://tis.eh.doe.gov:80/docs/osh_tr/otr.

KEYWORDS: confined space, training

FUNCTIONAL AREAS: Industrial Safety, Training and Qualification

4. WELDING ACTIVITIES STOPPED BECAUSE OF SAFETY VIOLATIONS

On September 17, 1997, at the Savannah River Site, an Occupational Safety and Hygiene Department safety engineer observed several unsafe practices during welding operations at the Vitrification Treatment Facility and stopped the welding activities. The safety engineer was conducting an inspection of a construction area while a subcontractor performed welding activities in support of melter construction. He observed a number of safety violations, including fire watch violations; failure to use protective equipment; and combustible materials in the immediate area.

Although these violations did not result in fires, personnel injuries, or fatalities, other welding and cutting events have resulted in these consequences. (ORPS Report SR--WSRC-RMAT-1997-0009)

The safety engineer observed the following unsafe practices.

- A welder wore a short-sleeved cotton T-shirt while welding.

  American National Standards Institute (ANSI) Standard Z49.1, *Safety in Welding, Cutting and Allied Processes*, paragraph 4.3, requires that workers wear clothing selected to minimize the potential for igniting, burning, or trapping hot sparks. It also provides additional criteria for flame-resistant protective clothing. 29 CFR 1910.132, *General Requirements*, also provides guidance for personal protective clothing, such as eye and face protection, gloves, aprons, and leggings.

- A fire extinguisher was not readily available, and another fire extinguisher designated for welding operations had not been inspected and was missing the pull-pin.

  29 CFR 1910.252, *General Requirements*, section (a)(2)(ii); 29 CFR 1917.152, *Welding, Cutting and Heating (hot work)*, section (c)(3); and 29 CFR 1926.352, *Fire Prevention*, section (d), require fire extinguishers to be available. A portable fire extinguisher of a type and size appropriate for the hazard should be provided for each fire watch and should be readily accessible. The extinguisher should be in good working order, as required by National Fire Protection Association (NFPA) Standard 10.

- The fire watch did not maintain a clear view of the work, did not have a fire extinguisher, and did not maintain the watch for 30 minutes after completion of the welding.

  29 CFR 1910.252, *General Requirements*, section (a)(2)(iii); 29 CFR 1917.152, *Welding, Cutting and Heating (hot work)*, section (c)(4); and 29 CFR 1926.352, *Fire Prevention*, section (e), require a fire watch. There may be circumstances when a fire watch may not be necessary, such as in a welding shop. When a fire watch is required, they shall have fire extinguishing equipment and be trained in its use. They shall watch for fires in all exposed areas and shall not be involved in other work activities. Where required, fire watches should remain in place at least 30 minutes after completing the welding and cutting operation as stipulated by NFPA Standard 51B, *Fire Prevention in Use of Cutting and Welding Processes*.

- A welder used a tarp that was not flame-retardant for shielding.

  29 CFR 1910.252 states that "cutting or welding shall be permitted only in areas that are or have been made fire safe." Section (a)(2)(vii) requires relocating combustible materials at least 35 feet from the work site. Where relocation is impracticable, combustibles shall be protected with flame-proofed covers or otherwise shielded with metal or asbestos guards or curtains. 29 CFR 1926.352, *Fire Prevention*, section (a), also requires moving any material that constitutes a fire hazard to a safe place.

The facility manager determined that the cause of the event was failure to follow safety procedures and inattention to detail.

NFS reported welding events in several Weekly Summaries. The following are recent examples.

- Weekly Summary 97-20 reported that a laborer at Hanford caught the leg of his coveralls on fire while cutting steel plates when a piece of hot metal (slag) dropped into the folds of his clothing. (ORPS Report RL--BHI-REMACT-1997-0005)

- Weekly Summary 97-11 reported that a welder at the Oak Ridge K-25 Site was fatally burned when two layers of his anti-contamination clothing and coveralls caught fire, engulfing him in flames. All of the clothing was cotton. A DOE Type A accident investigation determined that sparks or molten metal (slag) from the cutting operation ignited his clothing. (ORPS Report ORO--LMES-K25GENLAN-1997-0001)

- Weekly Summary 97-08 reported that a welder at the Savannah River Site received an electrical shock when his right arm came in contact with an electrode tip. He was repairing a condensate header with a tungsten inert gas welder and was lying on his back in the overhead piping. (ORPS Report SR--WSRC-HCAN-1997-0008)

These events illustrate the potential dangers involved in welding, cutting, and grinding activities. Burns of the eye or body are also serious hazards of welding. To prevent these injuries, protective equipment appropriate to the specific welding activity should be worn. Welding shields and helmets protect workers' eyes and faces from infrared or radiant light burns, flying sparks, metal spatter, and slag chips. Fire prevention is another important consideration. Open flames, electric arcs, hot metal, sparks, and spatter are ready sources of ignition. Many fires are started by sparks that pass through small openings such as cracks or holes. A fire watch, trained in the use of fire extinguishing equipment and the facilities available for sounding a fire alarm, is a necessary element of fire protection. Another cause of the fatality at the Oak Ridge K-25 Site was the failure to designate a fire watch with appropriate personnel safety responsibilities.

Several publications provide guidance on welding and cutting safety and on reducing fire hazards. The following publications contain many general and specific recommendations and should be consulted by appropriate facility personnel.

- DOE/EH-0196, *Fire Prevention Measures for Cutting, Welding, and Related Activities*, Bulletin 97-3, 1997 (Issue 91-3 revised). The bulletin is available via the Internet at http://tis.eh.doe.gov:80/docs/bull/links.html.

- *Industrial Fire Hazards Handbook*, 3rd ed., National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, Massachusetts, 1990.

- *Cutting and Welding Processes*, Standard 51B, National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, Massachusetts, 1992.

- *Brazing Safely*, American Welding Society, Miami, Florida, 1992.

- *Arc Welding Safely*, American Welding Society, Miami, Florida, 1988.

- *Oxyfuel Gas Welding, Cutting, and Heating Safety*, American Welding Society, Miami, Florida, 1992.

- *Safe Practices*, American Welding Society, Miami, Florida, 1992.
- *Safety in Welding, Cutting and Allied Processes*, ANSI/ASC Z49.1-1988, American Welding Society, Miami, Florida, 1988.

KEYWORDS: welding, fire protection, protective clothing

FUNCTIONAL AREAS: Industrial Safety, Construction, Fire Protection